
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
U. S. Weather Bureau

Southern Region Technical Memorandum No. 34, April 1967

STUDY ON DURATION OF MEASURABLE PRECIPITATION AT LUBBOCK, TEXAS

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WBAS, Lubbock, Texas

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INTRODUCTION

The purpose of this study is to show how precipitation forecasts can be improved by using climatological statistics which have been established as practical guidelines of duration probability. It is also the objective to establish practical guidelines for the meteorologist, especially during periods of complicated weather-producing situations.

One of the most important problems confronting meteorologists is the forecasting of the duration of precipitation. There are two major problems, the most likely time of onset and the duration. There is a tendency for meteorologists to overforecast both occurrence and duration. In many cases it has been noted that rain will be continued in a forecast until it has ended or until the current synoptic situation has ceased to produce the phenomena. This study has revealed some significant guidelines that may be used during periods of uncertainty when usual forecasting techniques fail to provide an adequate practical answer.

Synoptic situations which produce short-to-moderate duration periods of precipitation offer the least difficulty in prediction. The greatest difficulty encountered in these cases is the timing of onset. Slow-moving systems or perhaps those which become quasi-stationary along with complex, out-of-phase, upper air structures offer the greatest difficulty in arriving at a feasible answer as to the length of duration. Occasionally, there are no synoptic indications as to when a rain producing pattern will end or change appreciably. In these cases, the available moisture is finally depleted despite an apparent continued moisture source and there has not been a noticeable change in the synoptic weather pattern.

During periods of uncertainty climatology can play its most effective role as a guideline for forecast decisions. It should be recognized that these statistics are offered only as an extra aid since they help to remove some of the uncertainties where current knowledge of dynamics of the atmosphere falls short in giving the answer.

It should be emphasized that the problem considered in this study is very important to the High Plains of Texas, especially for agricultural interests. The onset and duration of precipitation is of prime importance to farming operations such as planting, irrigating, spraying, and harvesting. The public and aviation interests are concerned with the timely forecast of the beginning and ending of precipitation. Practical guidelines such as the ones revealed in this study may be developed at other localities and at times will take some of the uncertainty out of precipitation forecasting.

DATA AND PROCEDURES

In the present study, a 15-year period of climatological records (1952 - 1966 inclusive) for the Municipal Airport at Lubbock, Texas was used. All periods of measurable precipitation were categorized by the month of the year on an hourly basis. The method used in this study is similar to that conducted by Hugh B. Riley of Birmingham, Alabama.[1] However, this study was begun prior to the publication of Riley's article.

The duration of measurable precipitation was determined by counting the number of hours that .01 inch or more was recorded until at least a 12-hour period elapsed with no measurable amounts being received. It was assumed that a precipitation-producing synoptic situation had ended or moved out of the area if the precipitation had ceased for a 12-hour period. If precipitation began again shortly after this 12-hour period it was assumed to have come from a newly developed weather-producing storm. Another important reason for selecting the 12-hour period for a cut-off point, is the fact that the Weather Bureau Forecast Verification is by 12-hour periods, as are the general periods of forecasts issued for the general public; namely, TODAY, TONIGHT,and TOMORROW.

As is often the case, measurable precipitation may only occur intermittently during any one precipitation period. Some of the hours will not show measurable amounts, but a measurable amount will occur again in less than 12 hours from the previous one. As much as 8 to 10 hours elapsed without any measurable amounts during a few of the rain periods. But the rain period was continued for a much longer time due to additional amounts thereafter. This is especially true where drizzle occurs for a period of 18 to 24 hours. Generally, a period of 24 to 48 hours or more elapsed between rain periods.

The rain periods were not separated into the standard 12-hour forecast periods in use at Weather Bureau Stations. Depending on the time of onset, a 12-hour rain might fall into two 12-hour forecast periods, and on rare occasions a rain duration of 14 or 15 hours might verify a forecast of rain in all three 12-hour periods of a 36-hour forecast. After analyzing the results of this study, it can be assumed that a rain duration forecast will be based on the most likely time of onset. That is, if a 12-hour rain is predicted to begin in the middle of the second 12-hour forecast period it would be forecast to last into the third period, or mainly for the second 24-hour period of the forecast.

The total number of rain cases for each month was tabulated by the number of hours of duration for the 15-year period of study at the Lubbock Municipal Airport. Next, this data was classified into 6- or 12-hour groupings; and finally summarized into percentage of occurrence by the different groupings. The latter was achieved by taking the number of cases in each period and then grouping and dividing by the total number of rain cases for the particular month. This procedure was carried out

[1] Riley, Hugh B., "Study on Duration of Measurable Precipitation at Birmingham," Technical Memorandum No. 27, October 1966.

TABLE 1

NUMBER OF RAIN CASES FALLING WITHIN CERTAIN HOURS OF DURATION
(15 year period 1952 - 1966) WBAS, Lubbock, Texas

	Duration of Precipitation (hours)							
Month	1-6	7-12	13-18	19-24	25-36	37-48	Abv 48	Total Cases
January	18	14	3	1	3	0	1	40
February	17	11	3	1	2	0	2	36
March	31	9	5	1	2	0	0	48
April	31	9	7	1	3	0	0	51
May	71	11	7	2	3	0	0	94
June	77	7	5	1	1	1	0	92
July	67	13	3	3	1	0	0	87
August	58	5	4	1	1	1	1	71
September	34	14	5	1	1	0	1	56
October	28	9	3	2	5	0	3	50
November	22	6	5	2	3	0	0	38
December	21	8	8	0	4	0	1	42
All Months	475	116	58	16	29	2	9	705

TABLE 2

DURATION PERCENTAGES FOR DIFFERENT PERIODS OF TIME
(Precipitation Occurrences for WBAS, Lubbock, Texas, 1952-1966)

Month	Duration of Precipitation (hours)									
	1-6	7-12	13-18	19-24	25-36	37-48	Abv 48	1-12	1-24	1-36
January	45	35	7	3	7	0	3	80	90	97
February	47	30	8	3	6	0	6	77	88	94
March	65	19	10	2	4	0	0	84	96	100
April	61	18	13	2	6	0	0	79	94	100
May	76	12	7	2	3	0	0	88	97	100
June	84	8	5	1	1	1	0	92	98	99
July	77	16	3	3	1	0	0	93	99	100
August	83	7	6	1	1	1	1	90	97	98
September	60	25	9	2	2	0	2	85	96	98
October	56	18	6	4	10	0	6	74	84	94
November	58	16	13	5	8	0	0	74	92	100
December	50	19	19	0	10	0	2	69	88	98
All Months	67	17	8	2	4	1	1	84	94	98

Note: The figures above are expressed in percentages from 0 to 100.

on a monthly and annual basis for each period grouping. Table 1 shows the number of rain cases falling within certain time periods--ranging up to 48 hours of duration. The cases which lasted beyond 48 hours were grouped in one column and labeled "above 48 hours". Table 2 shows the duration percentages for the different time periods on a monthly and annual basis using the data given in Table 1.

ANALYSIS

The statistics given in Table 1 and 2 give an excellent picture of rain duration expectancy as applied to particular synoptic situations for the various seasons of the year. In Table 2 the strong seasonal variation in rain duration stands out immediately. For example, in January only 45 percent of the rain cases lasted 6 hours or less; whereas, in June 84 percent of its rain cases ended in 6 hours or less. Considering a longer period, 93 percent of the rain cases in July had a duration of 12 hours or less as compared to only 69 percent in December. Some interesting comparisons can be made from the statistics in Table 1 and 2 to show the different weather types which frequent the Lubbock and High Plains of Texas area. For instance, in looking at October and November it can be seen that October normally has longer periods of rain. Where October has 8 cases of rain in 15 years lasting longer than 24 hours, November has only 3 cases. Percentagewise, 16 percent of October's rains last longer than 24 hours as compared to only 8 percent in November. This can be attributed to the fact that polar outbreaks have not reached sufficient strength in October to penetrate far enough south into Texas with the accompanying drier air. Some of the frontal systems become stationary across North Central Texas into Southwest Texas during October. When a high level trough develops over the Southwestern portion of the country, warm moist air from the Gulf of Mexico overrides the polar air at the surface. With slow-moving weather systems, extended warm frontal rains may result. These and other examples emphasize the significance of seasonal variations and the need for climatological guidelines that can help the forecaster.

In forecasting for the winter months, the probability of precipitation lasting longer than 12 hours after initial onset is generally 10 to 20 percent higher than for the summer months. However, exceptionally long rains beyond 36 hours are quite rare in all months.

The rainy season for Lubbock and the High Plains of Texas is considered to be mainly from May through September which corresponds with the growing season in this area. During this period about 65 percent of the normal annual rainfall is received mostly from showers and thunderstorms. Rainfall received during April is still rather light in comparison to May since southwesterly winds ahead of pacific cold fronts usually dry out the air mass over this area. Table 2 shows that during the spring season more of the rainfall cases end within 6 hours of onset toward the end of the season.

Maximum precipitation usually occurs during May, June,and July, when warm, moist tropical air is carried inland from the Gulf of Mexico. This air mass produces moderate to occasionally heavy afternoon and nighttime convective thunderstorms--sometimes with hail. However, during May and the early part of June, most of the shower activity is triggered by weak cold fronts and/or high level troughs moving eastward through the area. Heavy thundershower activity tapers off in July and August and increases again in the early part of September as cold fronts begin to move south into the area. For example, May has 71 cases with rain ending within 6 hours or less from initial onset as compared to only 31 cases for April. On a percentage basis, 39 percent of April's rains last longer than 6 hours as compared to only 24 percent for May. Extended further, it can be seen that only 16 percent of June's rains have a duration of more than 6 hours. This can be attributed to the fact that frontal systems moving into the area in April and May cause longer rain situations; whereas, most of the rainfall in June is of the air mass, convective type.

In viewing all months for this 15-year period of study, the drastic drop off in rain duration is very noticeable beyond the first 12 to 24 hours after initial onset. First, it can be seen from the statistics in Table 2, that if a forecast called for measurable rain continuing beyond the first 12 hours it could not expect to verify more than 26 percent of the time except during the month of December where it would be given a 31 percent chance. Secondly, if a forecast called for measurable rain to continue past the first 24 hours, the verification would be 12 percent or less except in October when it would increase to 16 percent. However, on the average the forecast would verify only 6 percent of the time beyond the first 24 hours. For the months of March through September the climatological verification would show less than 5 percent over an extended period of time. Of course, a meteorologist may have the ability to select the long rain situations and, therefore, could have a much higher verification than is indicated statistically. However, a word of caution should be given to those faced with a potential long rain period to use all available means when predicting extended duration of precipitation.

CONCLUSION

Since this investigation has shown that precipitation duration forecasts are very often extended beyond extremely low probability limits, the need for practical guidelines is evident. Climatological statistics provide a source for improving forecasting rainfall duration when current forecasting techniques fail to provide an adequate practical answer.

Because the weather effects are so vital to agricultural interests on the High Plains of Texas, the practical guidelines established in this study should help to improve the accuracy of forecasts of probable duration of rainfall once the onset has been determined. Frontal weather is most active and the movement of weather systems is generally more systematic during the late fall, winter,and spring seasons when extended rain forecasts are most frequent. In most cases, the time of onset can be determined to the most probable 6-hour period in a 24-hour forecast, and to the nearest 12-hour period for longer predictions. After this problem has been solved, the probable duration period can be ascertained from the type of situation and speed of movement, keeping in mind the statistical probability as shown in this study.

Although this study was designed specifically for Lubbock, Texas, and the surrounding area, the results may be favorably applied to all of Northwest Texas because of a similarity in the climate. The climate of this area is mainly semi-arid, transitional between desert conditions on the west and humid climates to the east and southeast.